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[001] # HYDRAULICALLY ACTUATABLE GEARSHIFT SYSTEM COMPRISING A SYNCHRONIZING DEVICE

[002]

[003]

[004] The present invention relates to a transmission shift system comprising a synchronizing device for idler wheels pursuant to the preamble of patent claim 1.

[005]

[006] From the state of the art is known of transmission shift systems for idler wheels. In the familiar transmission shift systems, generally, synchronizing devices are provided for the purpose of synchronizing the idler wheels, wherein the devices mechanically actuate the sliding sleeves in order to synchronize the desired idler wheel with a shaft. This way the necessary torque is transmitted from the idler wheel to the shaft or vice versa.

[007] Generally, a displaceable sliding sleeve is used as the shifting element, having an appropriate profile, which slides onto the profile of the counter-piece upon actuation. For this, it is required that the normally existing RPM differential between the idler wheel and the shaft first assumes the value zero. Otherwise, it is not possible to connect the two profiles without resulting in undesirable grating in the transmission. Accordingly, the two profiles should only come into contact with each other when the rotational speeds between the idler wheel to be shifted and the shaft have been balanced. Therefore, a locking synchronizing device is provided, which prevents early shifting through a mechanical locking device.

[008] The publication DE 37 11 490 C2 discloses a gear shifting device. In this gear shifting device, the sliding sleeve is actuated by an adjusting arrangement accommodated in the shaft and operated by means of hydraulic fluid, wherein the arrangement consists of a hydraulically actuatable piston arrangement. A connecting pin, which connects the sliding sleeve with the hydraulic piston arrangement, is provided, which extends through a hole with axial play that is arranged transversely in the shaft. The familiar gear shifting device disadvantageously requires a very complex layout, since the actuating device or

piston arrangement is accommodated in the gear shaft. This affects the manufacturing costs of the familiar gear shifting devices negatively.

[009] From the publication GB 2 214 248 A is known of a gear ratio selection mechanism for a motor vehicle transmission. The mechanism utilizes fluid-operated actuators and an electro-hydraulic driver. With a first actuator the desired gear ratio is selected and, with a second actuator, a movement in the direction of the neutral path is enabled, wherein the first actuator activates a desired gear ratio by moving transversely to the neutral path. Furthermore, potentiometers are provided, which allow the respective positions of the actuators to be determined and be passed on to a control system in the form of signals.

[010] It is the object of the present invention to suggest a transmission shift system of the aforementioned kind, which comprises a synchronization device with a simple design of which easy and also secure synchronization can be achieved.

[011] This objective is achieved pursuant to the invention through the features of patent claim 1. Further variations and advantages result from the dependent claims.

[012]

[013] Accordingly, according to the invention, a transmission shift system with a synchronization device is suggested, in which a synchronizing operation is enabled during the shifting operation in a simple fashion. In particular, additional mechanical components of a locking device can be foregone in the transmission shift system according to the invention. By actuating the sliding sleeve hydraulically and by connecting the sliding sleeve with the shaft, via a hub element, the RPM adjustment of the idler wheel to be shifted and the shaft can be implemented in a simple manner. As a function of the actuation pressure, the sliding sleeve can be axially displaced in such a way that, initially, the existing rotational speed difference between the idler wheel and the shaft is compensated. After the rotational speed adjustment has occurred, the sliding sleeve can then be displaced axially in such a way that the sliding sleeve engages with the idler wheel to be shifted.

[014] Within the framework of further developing the invention, a catch device can be provided for driving the axial movement of the sliding sleeve or of the hub element. The catch device can be a spring-ball element or the like. It can be provided that the hub element comprises a bore in the radial direction in which the spring-loaded ball of the spring-ball unit is guided. The ball is pushed into a groove provided in the sliding sleeve by the spring. Through the actuation pressure acting in the axial direction, the sliding sleeve can be moved in the axial direction. As a function of the amount of the actuation pressure, the catch device releases the sliding sleeve at a predetermined actuation pressure P_s so that it can mesh with the idler wheel once the same RPM exists for the idler wheel and the shaft. It is also conceivable that other mechanically or similarly operated catch devices are used for the transmission shift system according to the invention.

[015] Preferably, the hydraulic actuation of the sliding sleeve is provided by an actuating piston or the like. Upon the piston pressure can be applied via an oil supply system so that the sliding sleeve is displaced axially in a corresponding fashion. It is also feasible that other actuating types are provided for the sliding sleeve.

[016] According to a further beneficial development of the present invention, at least one disk, which is preferably designed as a brake plate, can be provided to adjust the RPMs between the idler wheel to be shifted and the shaft. Every brake plate comprises corresponding friction surfaces, which are preferably coated with a suitable material in order to enable RPM adjustment in the simplest manner.

[017]

[018] The invention is explained in further detail in the following based on the attached figures. They show:

[019] Fig. 1 is a cross-sectional partial view of a possible embodiment of a transmission shift system pursuant to the invention;

[020] Fig. 2 is a possible course of the actuation pressure during the synchronizing process; and

[021] Fig. 3 is a cross-sectional partial view of another embodiment of the transmission shift system pursuant to the invention.

[022]

[023] Fig. 1 shows a possible embodiment of the transmission shift system according to the invention. The transmission shift system comprises a synchronizing device for idler wheels 2. At least one sliding sleeve 6, which can mesh with an idler wheel 2 that is to be shifted, is provided. The sliding sleeve 6 is arranged non-rotatably and axially displaceable on a shaft 1, wherein the sliding sleeve 6 can be hydraulically actuated by means of an actuating piston 10. The idler wheel 2 is arranged rotatably on the shaft 1 and meshes with additional torque-transmitting elements.

[024] According to the invention, it is provided that the sliding sleeve 6 is connected with the shaft 1 via a hub element 7 wherein, as a function of the hydraulic actuation pressure, an existing RPM difference between the idler wheel 2 to be shifted and the shaft 1 is compensated. Accordingly the shaft 1 and the idler wheel 2 to be shifted are connected so as to transmit torque. This way, the synchronizing operation is achieved with minimal design effort and in the quickest possible fashion.

[025] For the purpose of adjusting the RPMs during the synchronizing operation, the idler wheel 2 to be shifted is clamped between two disk elements 4, 5. The two disk elements 4, 5 are connected non-rotatably with the shaft 1 via profiles, wherein the disk elements 4, 5 each comprise a friction surface on the sides facing the idler wheel 2, said surfaces being suitably coated. The clamping force that is required for the synchronizing operation is applied hydraulically onto the sliding sleeve 6 by the actuating piston 10. The actuating piston 10 is returned into its starting position after synchronizing by means of a return spring 11.

[026] For the purpose of driving the axial motion of the sliding sleeve 6, a suitable catch device is provided on the hub element 7. The catch device comprises, in the embodiment shown here, a so-called spring-ball unit, which is provided in a bore

of the hub element 7. A ball 9 of said unit is pushed into a catch groove of the sliding sleeve 6 by a spring element 8.

[027] The selected design of a catch groove 3 combined with the amount of the spring force determines the necessary axial displacement force that must be applied onto the sliding sleeve 6 before said sleeve can move out of the starting position.

[028] If said force is lower than the release force, the sliding sleeve 6 remains locked in its position. Said force can, however, be used to apply a suitable clamping force onto the disk elements 4, 5. This way the disk elements 4, 5 are pressed against the idler wheel 2 to be shifted so that the RPM difference between the idler wheel 2 and the shaft 1 is compensated. Preferably at least the disk element 4 comprises a stop element 14 in the axial direction.

[029] The ball 9 and the spring 8 are guided in a bore in the hub element 7, which is provided loosely displaceable in the axial direction on the shaft 1. The hub element 7 rests directly against the disk element 5. The disk element 5, like the hub element 7, is connected to the shaft 1, via a profile, in order to transmit the necessary torque from the sliding sleeve 6 onto the shaft 1 in the shifted state.

[030] As soon as the force, acting upon the sliding sleeve 6 from the actuation pressure, exceeds the release force, the ball 9 can be pushed out of the groove 3 into the bore against the spring force of the spring element 8, so that the sliding sleeve 6 is axially displaced and can mesh with the idler wheel 2. When the ball 9 is located outside the catch groove 3, the clamping force, that is applied on the idler wheel 2, is also reduced to zero. This way, the corresponding meshing of the two splines of the idler wheel 2 and the sliding sleeve 6 can be beneficially facilitated.

[031] When releasing the connection, the sliding sleeve 6 can be pulled into the opposite direction by the return spring 11 of the actuating piston 10. The ball 9 can reach the catch groove 3 of the sliding sleeve 6 and, this way, the hub element 7 is removed from the disk element 5. Accordingly, the clamping force can be completely eliminated from the idler wheel 2.

[032] Accordingly, no additional mechanical locking device is required in the transmission shift system according to the invention. The synchronizing operation, provided with the transmission shift system, is essentially accomplished by applying pressure onto the actuating piston 10. The actuation pressure can preferably, as shown in Fig. 2, be adjusted in two steps. In the non-switched state, the actuation pressure can be equal to the pressure P_0 at the time t_0. The pressure P_0 is so low that no force counteracts the return spring 11 of the actuating piston 10.

[033] During the start of a shifting operation, the actuation pressure is increased to its first step, i.e., to the pressure P_1. Through the pressure P_1 it is accomplished that the actuating piston 10 can be moved against the spring force of the return spring 11, wherein the excess force on the actuating piston 10 is then axially transmitted onto the sliding sleeve 6. The actuation pressure P_1, however, is not able to apply sufficient force onto the sliding sleeve 6 to displace it against the catch device.

[034] This way the force is transmitted onto the disk element 5 via the ball 9 and the hub element 7. As long as the actuating pressure P_1 is applied, a corresponding clamping force acts upon the idler wheel 2, and the existing RPM difference between the idler wheel 2 and the shaft 1 is compensated. The time during which the application pressure P_1 is applied is the corresponding synchronizing time, which is specified by the time interval $t_{1,2}$ in Fig. 2. It should be noted that said time is sufficiently great to enable a suitable speed adjustment. This can occur by measuring the respective rotational speed of the shaft 1 and of the idler wheel 2, whereby the synchronizing time $t_{1,2}$ is determined then. It is also conceivable that the synchronizing time is known since it is known what state all rotating parts in the transmission are in, and the respectively required time for the synchronizing operation can be determined.

[035] When the RPM adjustment has been made, the actuation pressure can be raised to the second step, i.e., to the pressure P_2. The actuation pressure P_2 is large enough to overcome the release forces on the catch device. This way the sliding sleeve 6 is axially displaced in such a way that it can mesh with the idler

wheel 2. It should be noted that the actuation pressure P_s, marked in Fig. 2, is the appropriate pressure at which the release takes place. The actuation pressure P_s here is between the two actuation pressures P_1 and P_2. The amount of the distance from P_s to P_1, as well as the amount of the distance from P_s to P_2 must each be so large that all system tolerances of the transmission are taken into consideration.

[036] The pressure course, illustrated in Fig. 2, is only provided by way of example so that other random application force progressions are also feasible with the transmission shift system according to the invention.

[037] Fig. 3 shows another possible embodiment of the transmission shift system, according to the present invention, wherein identical components were marked with the same reference numerals as in Fig. 1.

[038] The embodiment can be preferably used when greater torque is required to adjust the speed differential between the idler wheel 2 and the shaft 1. This is accomplished in that an additional brake plate 13 is provided in the axial direction between the hub element 7 and the disk element 5. This results in additional friction surfaces, thus being able to apply a greater brake torque onto the idler wheel 2 to be shifted. Preferably, the brake plate 13 has exterior splines, which engage with the same splines; the splines of the sliding sleeve 6 mesh with. Beneficially, this way the usable synchronizing torque doubles as well.

Reference numerals

1	shaft
2	idler wheel
3	catch groove
4	disk element
5	disk element
6	sliding sleeve
7	hub element
8	spring element
9	ball
10	actuating piston
11	return spring
12	oil supply system
13	brake plate
14	stop element